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Wyoming Governor's Executive Order 2011-5, Greater Sage-grouse Core Area Protection.

Attachment Paragraph No. 6. Noise: New noise levels, at the perimeter of a lek, should not exceed 10 dBA above ambient noise (existing activity included) from 6:00 pm to 8:00 am during the initiation of breeding (March 1 - May 15). Ambient noise levels should be determined by measurements taken at the perimeter of the lek at sunrise.

Although this section appears straightforward and logical, there are some important issues with the manner in which the section is worded that could lead to decreasing protection for greater sage-grouse. There are two fundamental problems with the current wording that should be addressed: 1) the manner in which "existing ambient" is established at "sunrise" (i.e. using the sunrise time period of 5 am to 7 am when grouse are displaying); and 2) using "existing ambient" as described in the EO as the basis for impact assessment. Below we explain both problems, and then offer recommendations for new language which avoids these problems and provides more clarity about how compliance should be assessed. We also address other issues: use of a fixed, state-wide ambient; use of 10 dBA over ambient as a threshold; situations where ambient currently exceeds threshold levels; adjusting hours of lekking; and addressing hours outside lekking.

Problem 1: Using the Time Period 5 am to 7 am to Establish "Existing Ambient"

Grouse display sounds can significantly increase sound levels when measured at the perimeter of a lek during display periods (Patricelli et al. 2013; Ambrose and Florian 2014). Although grouse often display from 1800-0900, the most intense period of display is 5 am to 7 am, making this time period particularly problematic for measurement of other sounds. For example, sound level measurements were made at two leks west of the Pinedale Anticline Project Area in April 2013 (Ambrose and Florian 2014). There were no gas field sounds audible at these leks, but common rural Wyoming sounds were present, including birds, insects, and wind through vegetation, as well as distant vehicles, aircraft, and common ranching/farming sounds. Sound levels from 5-7 am averaged 24.2 dBA, while sound levels during the entire lekking period averaged 15.8 dBA. Sound levels during the 5-7 am period were 2.6 times greater than sound levels measured over the longer time period from 6 pm to 8 am. These increases in sound levels during the 5-7 am period were attributable solely to grouse display sounds (determined via digital recordings). For this reason, the time period around sunrise, roughly 5-7 am during late March to early May, is not an appropriate time period to use for establishing existing ambient sound level.

Sound levels for the time period 6 pm to 5 am (to exclude grouse sounds) averaged 14.8 dBA (1.0 dBA different from 6 pm to 9 am). Thus, use of all hours during the display period, 6 pm to 9 am, to establish ambient and/or assess compliance will not be unduly influenced by grouse sounds and will represent sound levels for the entire display period.

Problem 2: Use of Changing or Fixed “Existing Ambient” for Assessing Impacts

The approach used in the current Executive Order is to include "existing activity" when establishing ambient sound levels. The problem with this approach is that existing ambient sound levels almost always increase incrementally over time, and with an ever increasing ambient sound level, protection for greater sage-grouse is reduced (Patricelli et al. 2013).

For example, assume sound levels at a lek in rural Wyoming are 15 dBA during the lekking period, 1800-0900. Assume in year 1 a gas drilling operation is proposed 4.0 miles away, leading to an increase in the sound level at the lek to 21 dBA. This is less than 10 dBA over existing ambient of 15 dBA, and thus would be in compliance with the EO. The new existing ambient at this lek would become 21 dBA. Then assume in year 2 a gas drilling operation is proposed 2.0 miles away, leading to an increase in the sound level at the lek to 27 dBA. This is less than 10 dBA over the existing ambient of 21 dBA, and thus would be in compliance. The new existing ambient would become 27 dBA. Then assume in year 3 a gas drilling operation is proposed 1.0 miles distant, leading to an increase in the sound level at the lek to 33 dBA. This is less than the 10 dBA over existing ambient of 27 dBA, and thus would be in compliance. The new existing ambient would become 33 dBA. And so on. In this example, the "existing ambient" increases incrementally with each new and closer activity, even though no single annual increase exceeded the 10 dBA over ambient threshold. This could continue until the drilling operation was 100 feet from the lek, with the same assessment of "no impact." However, the best available evidence suggests that additional noise will increase the impact on these leks, because sage-grouse do not adapt to the presence of noise over time (Patricelli et al. 2013). In a 3-year experimental introduction of noise to leks, Blickley et al. (2012a) found an immediate decline in male lek attendance, which did not abate over time, and increased stress hormones in the second and third years of playback (Blickley et al. 2012b). The inclusion of existing noise into ambient values clearly does not protect greater sage-grouse.

RECOMMENDED LANGUAGE FOR THE EXECUTIVE ORDER

Noise: Noise levels should not exceed 25 dBA at the perimeter of the lek during lekking hours (6 pm to 9 am) during the initiation of breeding (March 1 to May 15). This metric will be calculated using the median of all hours during the lekking period, 6 pm to 9 am. Using this metric, one or more hours may exceed 25 dBA, but the median of all hours will be <25 dBA. Outside of these times, reasonable efforts should be made to keep noise as close to these limits as possible. In situations where existing noise levels at leks exceed 25 dBA before project initiation, new projects should not contribute to an increase in sound levels at leks; this can be accomplished through noise mitigation measures, such as pad siting and sound baffles that limit the combined noise exposure. 25 dBA represents a level 10 dBA above existing ambient noise levels in sage-grouse habitats in rural Wyoming.

All measurement should be made at the perimeter of the lek, with a Type I Sound Level Meter (capable of measuring the acoustic environment of the study area), for a minimum of 7 days (to cover normal variability due to different meteorological conditions), during the lekking period (6 pm to 9 am). Microphone height should be 12” to approximate ear height of greater sage-grouse. The median of hourly L_{50} values during monitoring period should be used to assess compliance. Measurement methods should follow published standards of the American National Standards Institute (ANSI) or specified by the SGIT.

BACKGROUND ON RECOMMENDATIONS FOR REVISED LANGUAGE

Use of a Fixed, State-wide Ambient Sound Level

We recommend using a fixed “existing ambient” value state-wide rather than measuring ambient on a lek-by-lek or site-by-site basis for the following reasons: 1) because accurate measurement of ambient noise levels at each lek or development site is difficult and expensive, 2) because nearly every error in the choice, placement and maintenance of the equipment will lead to overestimation of ambient values, thus higher allowable noise limits (Patricelli et al. 2013), and 3) because even accurate measures would include existing activity in the baseline, leading to incremental increases in impacts to sage-grouse, as discussed above. The State of Wyoming, through the Sage-grouse Local Working Groups (LWGs), funded a recent effort to measure ambient noise levels in sage habitats in four of the eight LWG Areas in Wyoming in April 2014 (13-22 days, total of 1805 hours). The four working LWG areas were: Bighorn Basin, Wind River/Sweetwater River Basin, Bates Hole/Shirley Basin, and Upper Green River Basin. Lekking hours (6 pm to 8 am) averaged 14.2 dBA (L_{90}) and 15.4 dBA (L_{50}) (Ambrose et al. 2014a). Common sounds included in these L_{50} measurements were birds, insects, and wind through vegetation, as well as farming, ranching, vehicles, and aircraft (but absent oil and gas development or other continuous noise sources). Therefore, this value represents ambient noise levels in typical sage-grouse habitat in Wyoming with some audible anthropogenic sounds, but does not include sounds of developed industrial areas. American National Standards Institute (ANSI) recommends using the L_{90} as the “residual noise level” or “background ambient” and L_{50} as “existing ambient.” In rural areas of Wyoming, prior to development, L_{90} and L_{50} values are very similar (<1.0 dBA difference), thus the choice is inconsequential.

It is important to note sound levels reported in Ambrose et al. (2014a) were often near the lower limit (noise floor) of the sound level meters used (13.5 dBA). This means that actual environmental sound levels were lower than reported by the meters. At one location, a very sensitive, 1” low-noise microphone (noise floor = 0 dBA) was deployed simultaneously with a standard ½” microphone system. For this 7-day measurement period, the ½” microphone system reported L_{90} and L_{50} levels of 14.5 dBA and 16.7 dBA, respectively. For the same time period, the 1” microphone system reported L_{90} and L_{50} levels of 7.2 dBA and 14.0 dBA, respectively. In all likelihood, sound levels in rural, undeveloped Wyoming are lower than reported by Ambrose et al. (2014a) during lekking hours.

Recommendation: For the purposes of establishing noise stipulations relative to greater sage-grouse, we recommend using a state-wide ambient of 15 dBA.

Threshold Level of Impacts to Greater Sage-grouse due to Anthropogenic Sounds

Noise levels >10 dBA over ambient has been found to impact populations of songbirds (Nicholoff 2003, Dooling and Popper 2007). Several studies have suggested that anthropogenic noise is also detrimental to greater sage-grouse (Rogers 1964; Braun 1998; Holloran 2005) and recent studies demonstrate this impact by experimentally introducing industrial noise to otherwise undisturbed leks, finding declines in lek attendance as well as increased stress hormones and altered behaviors (Blickley 2012; Blickley et al. 2012a; Blickley et al. 2012b). However, these studies did not establish the noise levels at which these impacts occur. Recent research in the Pinedale Anticline Project Area south of Pinedale, WY, provides insight into this question. In the PAPA, 22 leks (19 in PAPA, 3 outside PAPA) were studied by counting male grouse at the leks (2000-2014) (Wyoming Department Game and Fish, unpublished data) and measuring sound levels at the leks (2013-2014) (Ambrose et al. 2014b). L_{50} dBA sound levels at the leks were strongly associated with Poisson transformed trends in grouse counts ($R^2 = 0.552$, $P < 0.001$); the higher the L_{50} dBA, the greater the likelihood of

a declining trend. Of the 19 leks in the PAPA, 6 had sound levels <25 dBA and 13 had sound levels >25 dBA. Of the 6 leks with sound levels <25 dBA, 3 had increasing trends and 3 had declining trends. Of the 13 leks with sound levels >25 dBA, 3 were increasing and 10 were declining (7 of these had no grouse present for the last 2 or more years). Average decline at leks with L_{50} >25 dBA was 61%. These data suggest that at L_{50} sound levels >25 dBA, negative impacts to grouse due to anthropogenic sounds begin to occur (see Figure 1).

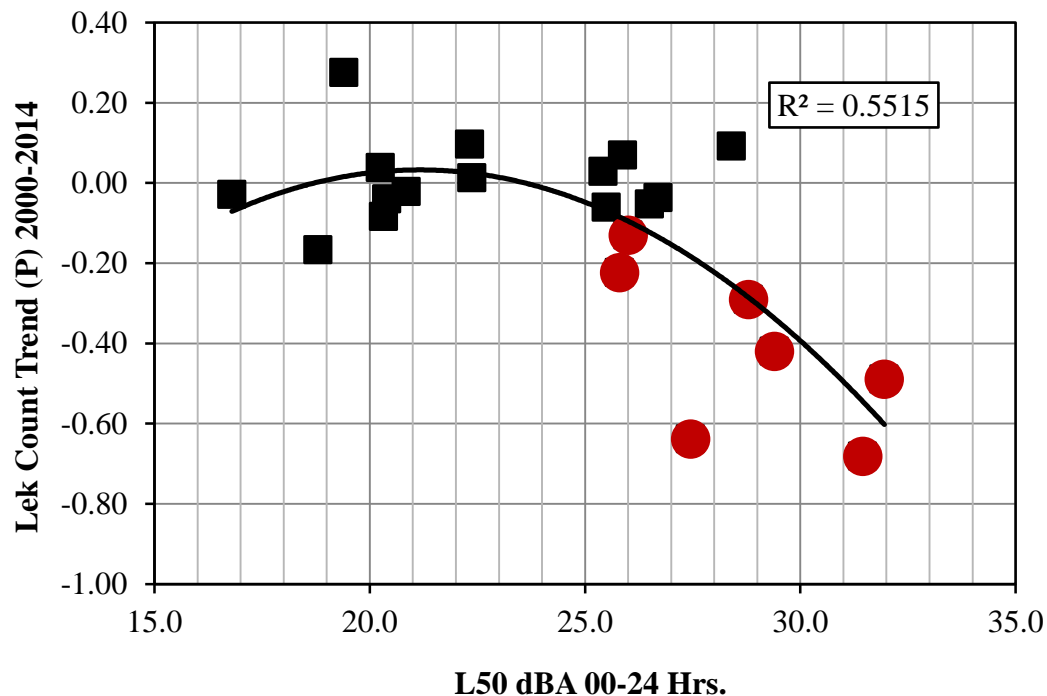


Figure 1. Trends of grouse counts (2000-2014) and L_{50} dBA levels (2013-2014) at 22 leks (19 in the PAPA and 3 outside the PAPA). Larger, red symbols indicate that the leks have been inactive for 2 years or more. Trend lines are polynomial regression analysis.

The use of 25 dBA is further supported by comparisons of the leks that have remained active or become inactive. We examined whether the proportion of leks that were inactive for at least the past 2 years (during noise measurement) was higher for leks exposed to median noise levels (L_{50}) of >25 dBA compared to leks exposed to <25 dBA. Of the leks that had L_{50} values <25 dBA, no leks (0%) were inactive; of the leks that had L_{50} values >25 dBA, 7 of 13 leks (54%) were inactive. Even in this small sample, this represents a significant increase in the probability of a lek becoming inactive when exposed to >25 dBA of noise (Fisher's Exact Test, $p=0.034$). Further, the median L_{50} of inactive leks (28.8 dBA) was significantly higher than the median L_{50} of active leks (23.9 dBA) (Mann-Whitney $U=8$, $p<0.005$).

Recommendation: For the purposes of assessing acoustic impacts to greater sage-grouse, we recommend using 25 dBA as the threshold for noise exposure (ambient 15 dBA + 10 dBA). For compliance with this limit, we recommend that measurement be made at the perimeter of the lek, with a Type I Sound Level Meter (capable of measuring the acoustic environment of the study area), for a minimum of 7 days (to cover normal variability due to different meteorological conditions) during the lekking period. The sounds of lekking birds will have minimal impacts on these measures (as discussed above). Pater et al. (2009) recommend noise measurement at the height most relevant to

assessing noise impacts on wildlife (see also Delaney et al. 1999, Patricelli et al 2013, and others), which is also consistent with ANSI standards (1994, Section 7.3.2.4), therefore we recommend that SLM microphone height should be 12” to approximate ear height of greater sage-grouse; this microphone placement will also reduce the impact of wind, which could artificially inflate measures and count against compliance. We recommend that the median of hourly L_{50} values during monitoring period should be used to assess compliance. Using this metric, one or more hours may exceed 25 dBA, but the median of all hours should be <25 dBA.

Situations When Existing Ambient Exceeds 25 dBA

There may be situations where sound levels at leks exceed an L_{50} of 25 dBA before project initiation due to existing noise sources, though recent data suggest that this is unlikely outside of heavily-developed areas (Ambrose et al. 2014a and 2014b). In these cases, the best available evidence suggests that additional noise will increase the impact on these leks, as sage-grouse do not adapt to the presence of noise over time (as discussed above; Patricelli et al. 2013). Therefore, to limit impacts on sage grouse, new projects should not contribute to an increase in sound levels at leks already exceeding the noise limits. This rule would not preclude further development at sites that already have sources exceeding 25 dBA due to the non-additive way that multiple sound sources combine to determine overall noise levels. For example, a new source with an L_{50} 9 dB quieter than the L_{50} of an existing source at the measurement site would add only 0.5 dB to the total noise exposure. Therefore new projects could proceed by increasing the distance to the lek or through the use of noise-mitigation technology.

Recommendation: New projects must not contribute to an increase in sound levels at leks already exceeding the noise limits.

Lekking hours of Greater Sage-grouse

The Executive Order currently applies to the hours between 6 pm to 8 am during the lekking season, but this leaves a significant portion of on-lek activity unprotected. Based on observations of attendance patterns and behaviors over 12 lek-years (5 leks, some in multiple years, between 2006 and 2014) near Hudson, WY, an average of 17% of copulations in a lek-year were observed to occur after 8am (this ranged from 4% in one lek-year to 41% in another lek-year) (Patricelli and Krakauer, unpublished data). Further, this same study found that the mean departure time of birds from their leks is approximately 9:00 am, with activity extending some days until 11 am. Studies of lek attendance in Colorado and Montana also found that lek activity commonly continues past 8 am (Jenni and Hartzler 1978; Walsh et al. 2004).

Recommendation: To protect lekking activities, we recommend that the protected period be extended to include 6 pm to 9 am.

Hours Outside the Lekking Period

Maintaining lek activity involves males and females foraging, roosting, nesting and brood-rearing before and after lekking times on a daily and seasonal basis, and noise impacts may also occur during these off-lek activities (e.g. Vehrencamp et al. 1989; Wallestad and Schladweiler 1974; Schoenberg 1982; Patricelli et al. 2013).

Recommendation: Outside of lekking times, reasonable efforts are recommended to keep noise as close to these limits as possible.

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